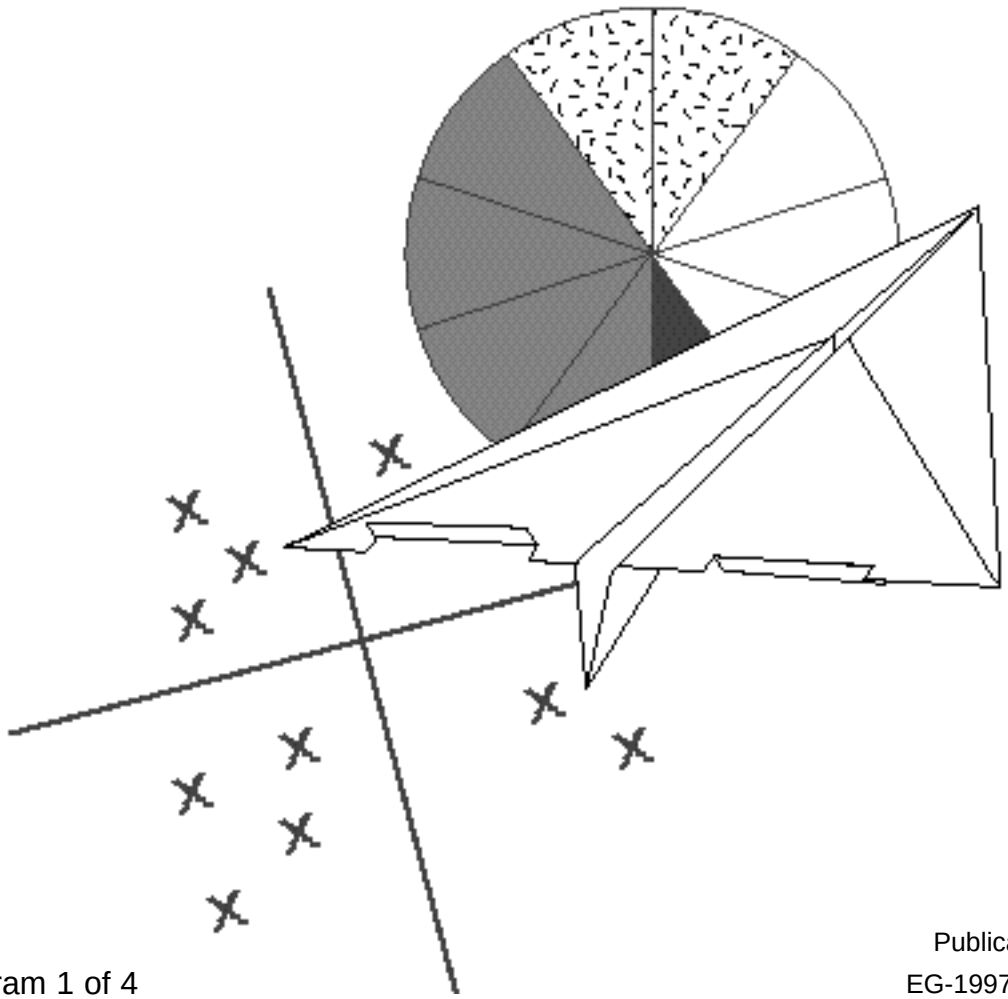
National Aeronautics and
Space Administration
Langley Research Center
Office of Education

Educator's Guide	
Teachers & Students	Grades K-8

CONNECT
VIDEO SERIES

Flight Direction



Program 1 of 4

Publication Number
EG-1997-10-03-LaRC

Background (Pgs. 2, 3, & 4)

- Introduction to CONNECT Series
- Introduction to Flight Direction
- NASA's Contribution to Aeronautics

Need More Copies?

Section 1

This section contains valuable information concerning the CONNECT Series and *Flight Direction*, program 1 of the CONNECT Series. This information will allow educators to become familiar with the purpose of the CONNECT Series and the *Flight Direction* program and to understand the aeronautics mission of the National Aeronautics and Space Administration (NASA).

We encourage the widest possible distribution and use of our educational programs and materials. Specifically, there is no claim of copyright by the U.S. government concerning the CONNECT series. Therefore, our permission is not required to either tape each broadcast or to copy the associated print materials for classroom use and/or retention in your school's library.

NASA Strategic Plan identifies "Educational Excellence" as one of its strategic outcomes and states:

"We involve the education community in our endeavors to inspire America's students, create learning opportunities, and enlighten inquisitive minds."

NASA – Investing in America's future through excellence in education

NASA is committed to promoting excellence in education, supporting the teaching profession, and increasing awareness of the impact science, mathematics, and technology will have on the quality of life in the 21st century.

INTRODUCTION TO THE CONNECT VIDEO SERIES

The CONNECT Video Series constitutes four, 30-minute interactive programs delivered to both K-4 and 5-8 audiences. Each program in the series will feature one of the four NASAStrategic Enterprises. It is this "content" that drives the uniqueness of the CONNECT programs. The Enterprises include Aeronautics and Space Transportation Technology, Human Exploration and Development of Space, Mission To Planet Earth, and Space Science.

SERIES OBJECTIVES

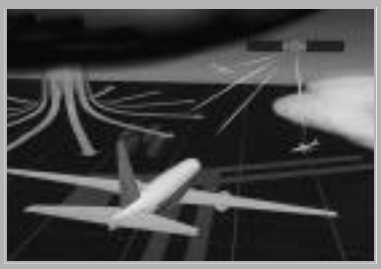
- Demonstrate the connection between the concepts and skills taught in the classroom and their application in the workplace.
- Address specific national mathematics standards and support state curriculum frameworks and standards.
- Actively engage students in problem solving, mathematical reasoning, and communicating mathematics.
- Build activities within the program's design that encourage students to apply mathematical operations involving number sense and numeration, measurement, statistics and probability, and patterns and relationships.

ABOUT THE PROGRAM FORMAT

- NASA Guest: features a NASA engineer, scientist, or technician to illustrate the application of classroom lessons to the workplace
- Activities: involves the use of hands-on activities drawn from the new release of the National Council of Teachers of Mathematics (NCTM) math activity books, *Mission Mathematics*, developed in collaboration with NASA
- Students: highlights elementary and middle school students and classrooms that have conducted and shared the results of program activities with viewers
- Challenge Point: includes pause period whereby students are presented with data and, working in pairs or small groups, are encouraged to analyze and interpret data
- Call-in: opportunity for students to call in (using phone, fax, or e-mail) questions for the guest about the topic and the activity
- Print Materials: provide registered educators with background on the program content and guest, on the featured activity, master copy of Challenge Point worksheets for copying and distribution to students, and additional resources
- Web Site: enables viewers to register for the program, to download print materials, to post questions to the featured guest following the broadcast, and to acquire additional information http://edu.larc.nasa.gov/connect/

NASA Aeronautics & Space Transportation Technology: Three Pillars for Success

Pillar One: Global Civil Aviation



Pillar Two: Revolutionary Technology Leaps

Pillar Three: Access to Space

INTRODUCTION TO FLIGHT DIRECTION

NASAengineers and pilots constantly experiment with test designs and materials to make the best airplanes. Their experiments are done over long periods of time. They change their experiments by varying the conditions.

In this program, students will be introduced to and will learn from former NASA test pilot Lee Person. They will observe students from McIntosh Elementary School (Newport News, VA) as these students conduct a paper airplane experiment in which different flight conditions are tested and changed. By working in pairs or small groups during the program's Challenge Point, program viewers will better understand how research teams of NASA engineers, technicians and pilots must work together to complete large projects involving airplanes.

LEARN ABOUT NASA'S CONTRIBUTION TO AERONAUTICS

NASA's responsibility is to provide revolutionary advancements that protect U.S. aerospace leadership for future generations. The impact of NASA's research on our national air transportation system, our national security, the environment, and our economy demonstrates a clear government role in support of the public good.

We can look forward to aircraft that are compatible with our environment and fly with a near perfect safety record, using an aviation system that provides rapid, affordable, dependable service for all. We think that flying will become as convenient in our personal lives as the automobile and integral to the way we do business.

Aeronautic engineers are always looking for the best ways to make new planes for commercial travel. One area of study is the High-Speed Research Program. Some day, supersonic transport could be a main way of commuting. That means flying faster than the speed of sound!

As more and more people continue to fly, air traffic is expected to go way up. NASAis working on planes that have tilted rotors to let the aircraft fly in and out of airports vertically, like helicopters.

Safety for all commercial flight is an important part of NASA research. NASA researchers have produced designs, materials, and techniques that have solved many safety problems. Now researchers are developing new computers and displays that will help pilots fly and land planes as safely as possible.

The NASAaeronautics centers are located at the NASAAmes Research Center (California), the NASA Dryden Flight Research Center (California), the NASA Langley Research Center (Virginia), and the NASALewis Research Center (Ohio).

NASA's science, mathematics, and technology education programs and activities leverage its inspiring mission, unique facilities, and specialized workforce.

At the **elementary and secondary levels**, NASA seeks to enhance the knowledge, skills, and experience of teachers and capture student interest in science, mathematics, and technology through the demonstration of integrated applications of related subject matter.

MEET THE PROGRAM HOST

DR. M. D. "SHELLEY" CANRIGHT

Dr. M.D. "Shelley" Canright serves as Precollege Officer in the Office of Education at NASA Langley Research Center, Hampton, Virginia. She is also responsible for providing the Nation's precollege-level teachers and students and teacher education colleges and universities with relevant programs and products based on NASA engineering and science programs and projects. Dr. Canright has 18 years of professional work experience in the field of education spanning from local (classroom and school board) to federal-level positions and experiences. Shelley has developed and managed a number of educational programs and projects and has received several honors and awards, including a U.S. Presidential Letter of Commendation, for her educational contributions.

MEET THE NASA GUEST RESEARCHER

LEE H. PERSON, JR.

Lee is a NASA (retired) research pilot who flew all the different airplanes used in Langley experimental programs. He has flown over 115 different flying machines, including conventional jet powered, helicopter, and vertical take off and landing types.

As a boy, Lee built and flew model airplanes, fixed and rode his motorcycle, and was an honor roll student in high school. Lee went to college for 2 years and then dropped out to become a Marine fighter pilot.

After completing his service, he went back to college more determined to study and learn. He earned a mechanical engineering degree with honors. Before coming to Langley in 1962 he worked in a cake mix plant. One day he got a call from a friend asking if he would like to go to work at Langley and use both his flying experience and his engineering degree.

Lee really enjoyed his job and says you learn something new each day as a research pilot. He still builds and flies model airplanes and says that he has found that there are no free lunches in life. You have to work to get anything you really want.

Section 2

Pre-Program Preparation Activity (Pgs. 5, 6, 7, 8, 9, 10, 11 & 12)

The information contained in this section is designed to prepare teachers and students to view the (video) program. There are three pre-program or preparation activities: (1) discuss with students what makes an airplane fly and the parts of an airplane, (2) divide students into small groups or pairs, and (3) prepare for the Challenge Point period.

Preparing for the Program

- What makes an airplane fly?
- The four forces of flight

Using the modern airplane as a backdrop, student produced paper airplanes are used to assist educators in introducing the following mathematical concepts and operations (i.e., number sense and numeration, measurement, statistics and probability, fractions and decimals, and patterns and relationships) in their classrooms. All students will benefit from having a general knowledge about the parts of an airplane. A diagram of an airplane is provided on pages 6 & 7. As part of the pre-program or preparation activities, educators may wish to discuss with their students, "what makes an airplane fly," and the four forces of flight (See page 8). During the video, the NASA guest will introduce students to the term "aeronautics" and the three "control surfaces" (e.g., ailerons, elevators, and rudder) that allow the pilot to maneuver the airplane (See page 9). The NASA guest will place special emphasis on the "ailerons," the control surface that helps the pilot turn the airplane.

Preparing for the Challenge Point Period

- Divide Students into small groups or pairs
- Make copies of appropriate Challenge Point worksheet (Pgs. 10 & 11)

To prepare for the program's Challenge Point period, prior to the start of the program:

1. Make copies of the appropriate Challenge Point Worksheet and distribute one copy per student .
2. Divide students into small groups or pairs. By working in small groups or pairs, students will better understand how NASA research teams must work together to analyze and interpret findings and communicate results in written, oral, and graph forms. (Depending on the students, teachers may wish to do the Challenge Point as a large group)

Program Materials

- Airplane Diagram
- Challenge Point Worksheet
- Colored Pencils or Crayons

Program Vocabulary

- aeronautics - *The science and art of designing, constructing, and operating aircraft.*
- control surfaces - *The movable parts on an aircraft's wings and tail which are used to turn or tilt the aircraft during flight.*
- aileron - *Movable parts of airplane wings, usually on the trailing (rear) edge near the wingtips. Moving the ailerons up and down makes the aircraft tilt, or roll, to one side or the other. Ailerons are joined by wires so that when one aileron moves up, the other moves down, making one wing rise and the other drop. This makes controlled turns possible.*
- elevator - *A movable airfoil similar to an aileron, usually attached to the tail of the plane. Elevators enable the plane to climb or dive. Lowering the elevators makes the aircraft's nose go down and the tail pitch up. Raising the elevators makes the nose come up and the tail go down.*
- rudder - *The rudder is located on the tail. It moves the airplane's nose to the left or right. The pilot pushes foot pedals to control the rudder.*

IDENTIFY AND LEARN ABOUT THE PARTS OF AN AIRPLANE

The following suggestions will prepare the students for the program and help focus their attention to specific elements within the program's content.

IDENTIFY THE PARTS OF THE AIRPLANE

Make a transparency of the airplane diagram (See Pg. 7). Depending on the grade- and ability-levels of your students, determine how much of the airplane parts to show and how much detail to discuss. You may want to cover some of the parts and focus on just specific parts. The airplane part that will be covered in the program is the aileron.

1. Show the diagram on the overhead projector.
2. Tell students that airplanes are equipped with special control surfaces to give the pilot a way to maneuver the plane. Have them identify what they think are control surfaces *(rudder, elevators, and ailerons)* on the airplane. What do they think each surface controls? (*The rudder controls "yaw", the side-to-side movement of the plane; the elevator controls "pitch", the up and down movement of the nose of the plane, and the ailerons located on the wing control "roll", to the right or left side of the plane. Ailerons always move in opposite directions — when one aileron is up, the other is down*)
3. Tell students that in this program the **aileron** is the focus.

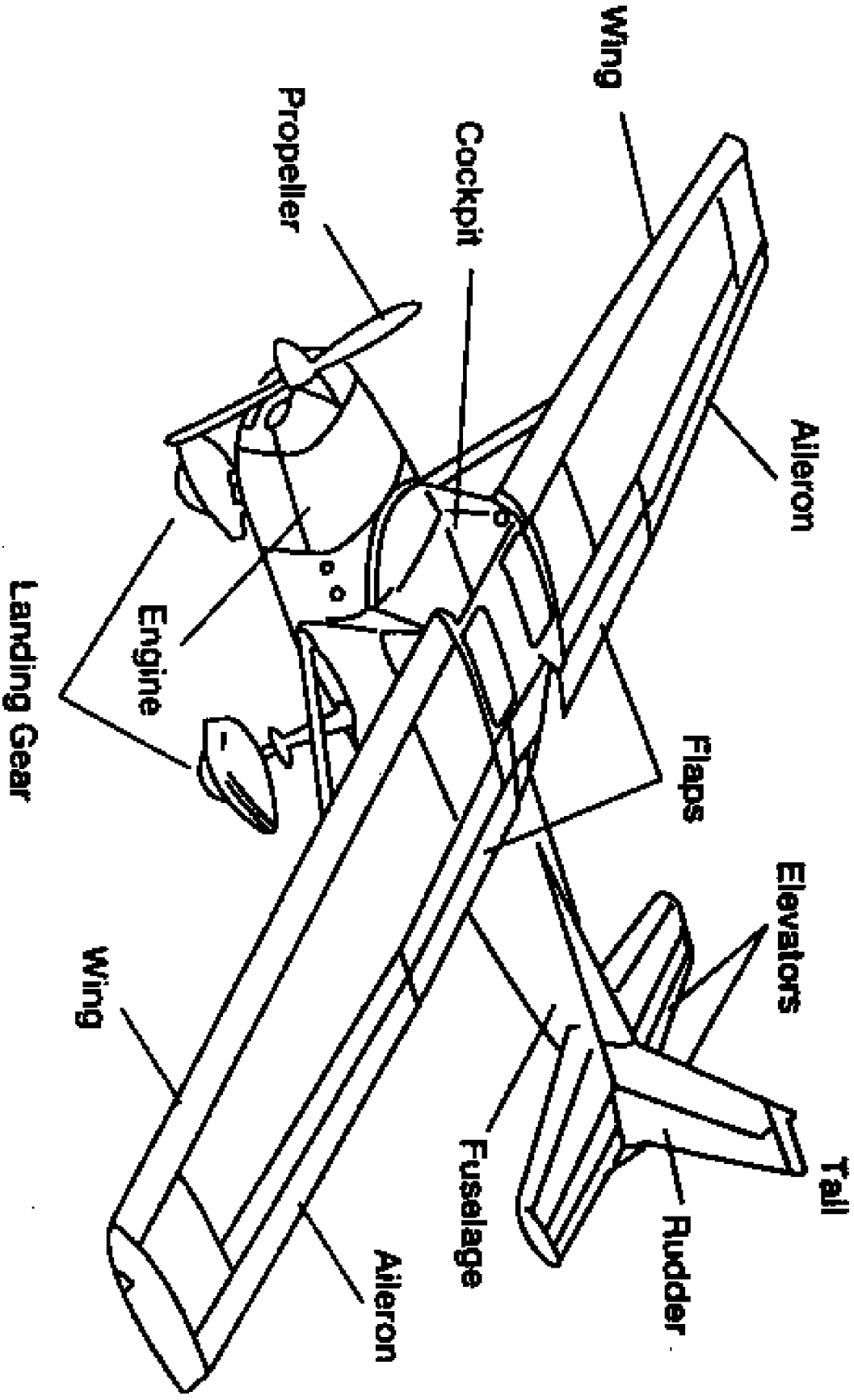
VOCABULARY

1. Introduce the five vocabulary terms: aeronautics, control surfaces, ailerons, elevator, and rudder.
2. Have students locate the ailerons on the airplane. What function might the ailerons have with flying an airplane? Have students look up the word and compare responses to the definition.

DISCUSSION QUESTIONS

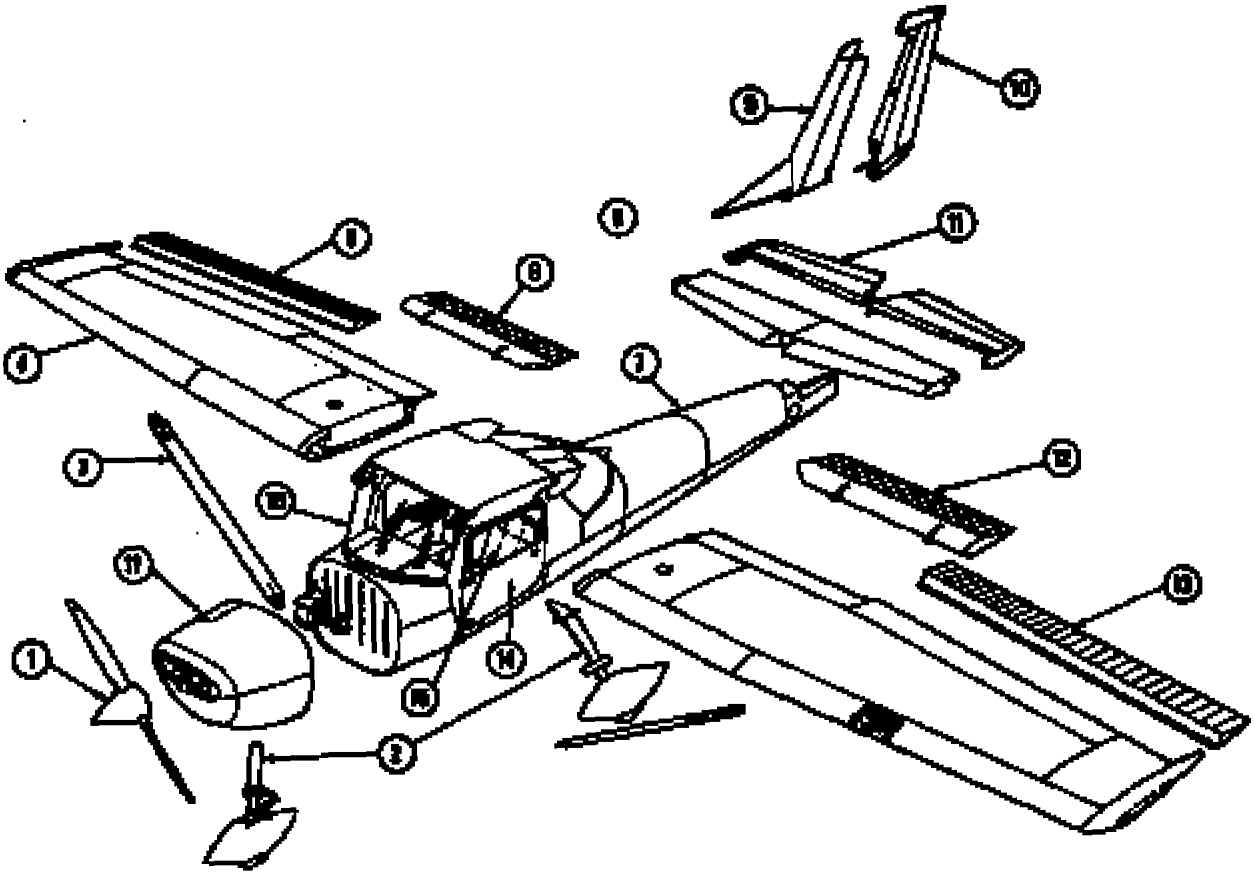
List the following questions on the board. Have students discuss each question. Questions very similar to these will be asked of the featured guest. Following the program, go back to the questions and re-discuss.

1. What is the difference between a commercial and a research pilot?
2. How might mathematics be used by a research pilot?
3. What types of investigations, or experiments, might be performed on airplanes?


Wing
Propeller
Cockpit
Aileron
Engine
Landing Gear
Flaps
Elevators
Wing
Fuselage
Tail
Rudder
Aileron

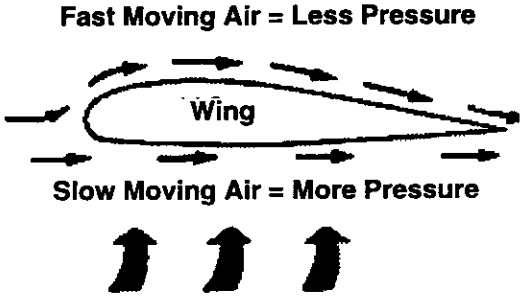
THE MAIN PARTS OF AN AIRPLANE

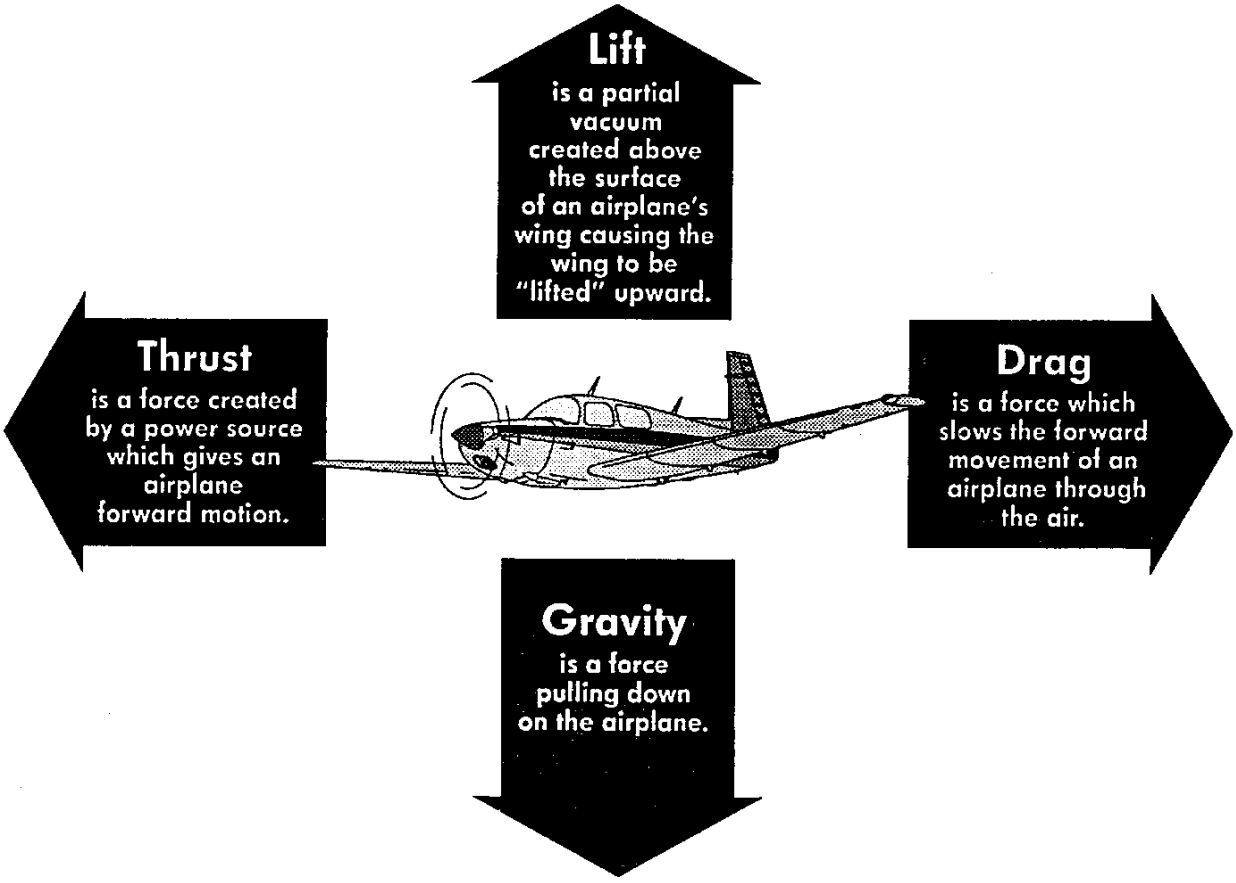
1. Propeller
2. Landing Gear
3. Wing Strut
4. Wing
5. Right Wing Aileron
6. Right Wing Flap
7. Fuselage
8. Horizontal Stabilizer
9. Vertical Stabilizer
10. Rudder
11. Elevator
12. Left Wing Flap
13. Left Wing Aileron
14. Door
15. Seat
16. Windshield
17. Engine Cowl



BERNOULLI'S PRINCIPLE

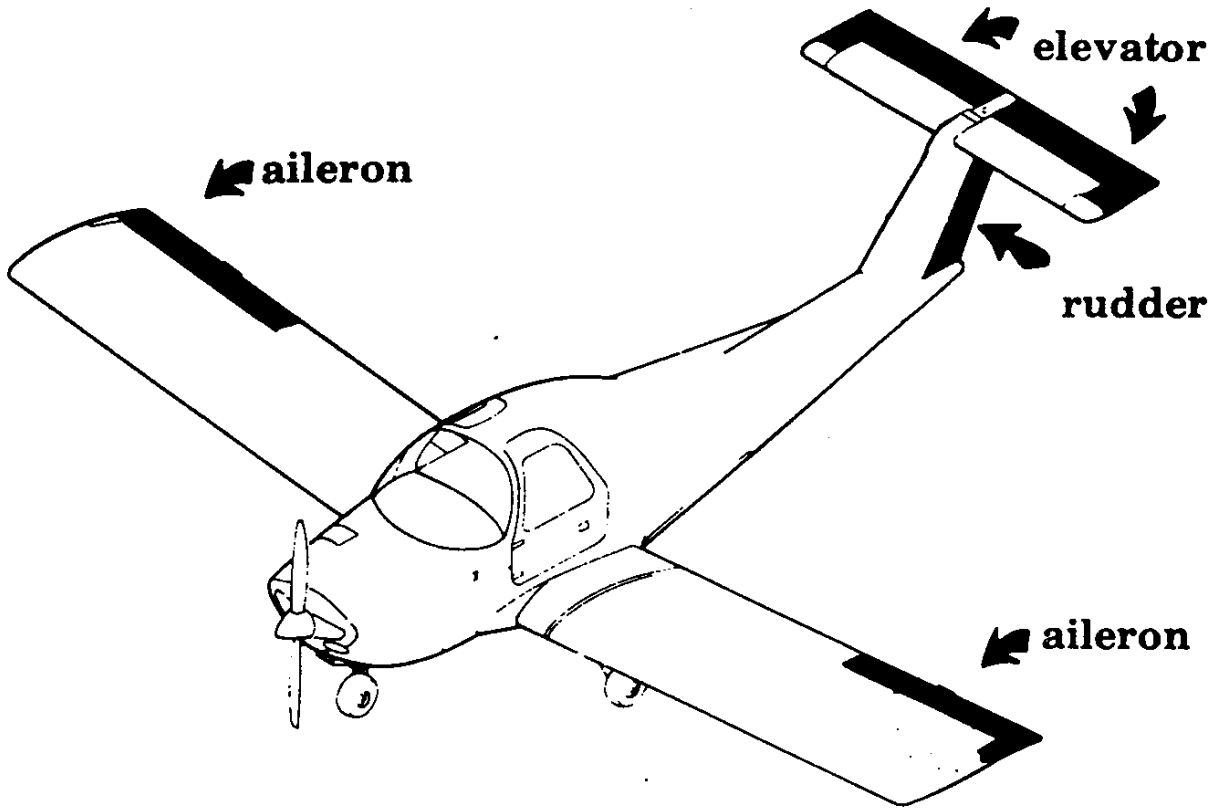
Daniel Bernoulli, a Swiss physicist, discovered that "as the velocity of a fluid increases, its internal pressure decreases." This is what enables an airplane to fly.





CONTROL SURFACES

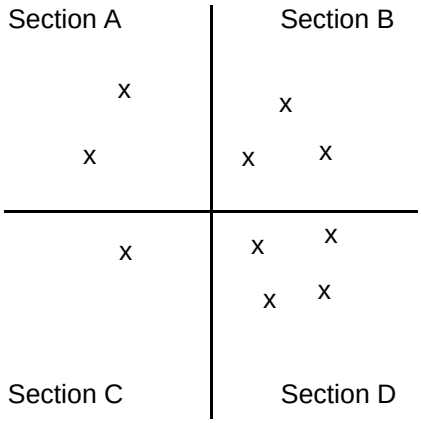
Planes have segments called control surfaces inserted in wings, in the vertical stabilizer, and in the horizontal stabilizer. These are the ailerons, rudder and elevator. The pilot controls their position from the airplane cockpit. When the pilot moves them into the airstream, they cause the plane to react to air pressure. The plane moves left and right, and up and down.



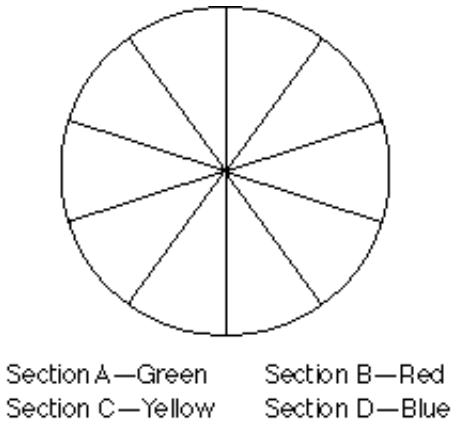
CHALLENGE POINT WORKSHEET
PRIMARY LEVEL (K-4)

McINTOSH STUDENTS' FLIGHT DATA

Control Flight
Flight Results: No Ailerons



Circle Graph: No Ailerons



1. Which section of the target did the McIntosh Team's planes hit the most? The least?

   MOST: Section _____ LEAST: Section _____

2. What patterns do you notice in the data for their airplane?

   _____

   _____

   _____

3. Of the 10 landings, how many were in section A? In section B? In section C? In section D?

   Section A:_____ Section B:_____ Section C:_____ Section D:_____

4. How might this data be displayed in a circle graph? Discuss ideas and write down your group's best idea.

   _____

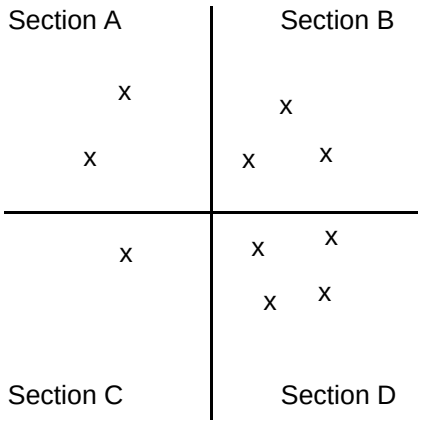
   _____

   _____

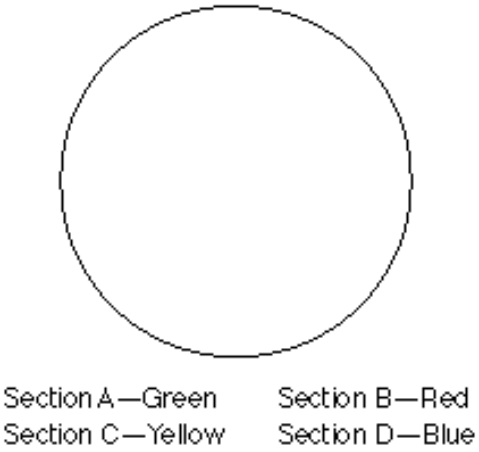
CHALLENGE POINT WORKSHEET
INTERMEDIATE LEVEL (5-8)

McINTOSH STUDENTS' FLIGHT DATA

Control Flight
Flight Results: No Ailerons



Circle Graph: No Ailerons



1. Which section of the target did the McIntosh Team's planes hit the most? The least?
   MOST: Section _____ LEAST: Section _____

2. What patterns do you notice in the data for their airplane?

   _____

   _____

   _____

3. Of the 10 landings, how many were in section A? In section B? In section C? In section D?

   Section A:_____ Section B:_____ Section C:_____ Section D:_____

4. Discuss how the number of landings in a section can be expressed with either a fraction or decimal. Organize the data in the displayed table.

Area	No. of Landings	Total Flights	Fraction	Decimal
Section A		10		
Section B		10		
Section C		10		
Section D		10		

5. Color the circle graph to summarize landing results for each section of the sample data.

Section 3

Viewing the Program
(Pgs. 13, 14, 15, 16, 17 & 18)

Viewing the Program

The *Flight Direction* program introduces students to the field of aeronautics by way of a dialog between the program host and a NASA research pilot. The program also shows a paper airplane experiment conducted by students at McIntosh Elementary School (Newport News, VA). These students model the type of research done at NASA by using mathematical concepts. The experiment, which measures the flight direction of paper airplanes, generates data that your students will be challenged to interpret and analyze during the program's Challenge Point period.

Interactive Challenge Point

Challenge Point Period

This interactive program requires that each student record data on worksheets that are used during the program. It's important to note that there are student worksheets and teacher answer keys. There are also **two** different programs, K–4 and 5–8.

Grades K–4 Challenge Point

The K-4 show and the Challenge Point will emphasize number sense and numeration, measurement, and patterns and relationships. (The K–4 answer key is page 15.)

Grades 5-8 Challenge Point

The 5-8 show and the Challenge Point will emphasize number sense and numeration, measurement, statistics and probability, fractions and decimals, and patterns and relationships. (The K–4 answer key is page 16.)

Further Exploration

A listing of online aeronautics education resources appears on pages 17 & 18.

Evaluation Card

What did you think of Flight Direction, CONNECT Program 1? Please complete the enclosed postage-paid evaluation card.

NCTM Standards

- Number Sense and Numeration
- Measurement
- Statistics and Probability
- Fractions and Decimals
- Patterns and Relationships

Program Objectives

- Observe experiment: collect, organize, display and interpret data
- Convert data to graph/table form
- Work cooperatively in pairs/teams

Challenge Point Assessment Tip

- Observe which students can use a data-collection form and which students need to learn how
- Talking and writing about solutions helps students confirm their learning

THE PROGRAM CHALLENGE POINT

Built within the program's design is a pause period where students will be asked to look at data generated by the Macintosh students' flight control experiment and, working in pairs or small groups, respond to questions and complete tables or graphs detailed on the Challenge Point Worksheet (See p. 14 & 16). This period of the program is key, for it is during this period that the NCTM standards are confronted within the lesson.

DURING THE CHALLENGE POINT PERIOD

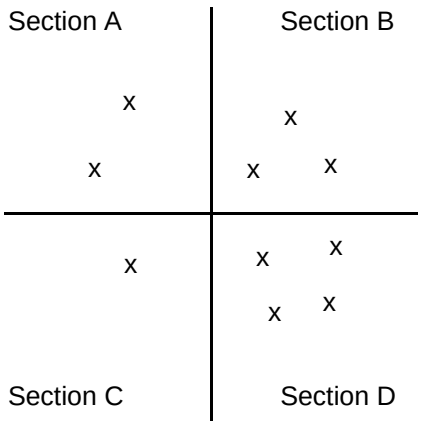
During this program segment, the teacher acts as a facilitator, supporting and guiding the students in discussion and responding to the worksheet questions. In doing so:

1. Have the students observe the flight results data presented in the video, as indicated with Xs in the different sections (A, B, C, D).
2. Each of the questions listed on the Challenge Point worksheet will be presented one at a time during the program. Students will have a limited amount of time to discuss the question with their partner(s) and write down a response.
3. Feedback to the questions will be presented at the end of the Challenge Point period. Have the students review their answers. Following the program, continue discussions if necessary.

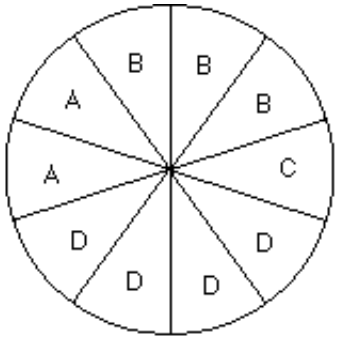
CHALLENGE POINT WORKSHEET ANSWER KEY
PRIMARY LEVEL (K-4)

McINTOSH STUDENTS' FLIGHT DATA

Control Flight
Flight Results



Circle Graph



Section A—Green Section B—Red
Section C—Yellow Section D—Blue

1. Which section of the target did the McIntosh Team's planes hit the most? The least?

   MOST: Section D LEAST: Section C

2. What patterns do you notice in the data for their airplane?

3. Of the 10 landings, how many were in section A? In section B? In section C? In section D?

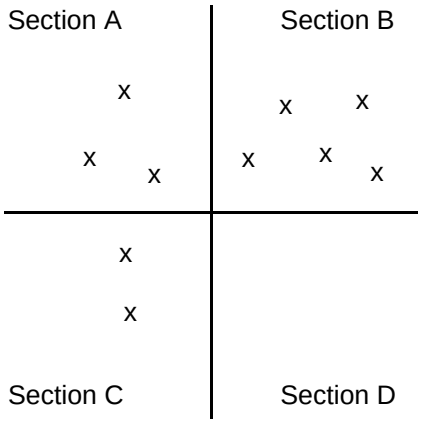
   Section A: 2 Section B: 3 Section C: 1 Section D: 4

4. How might this data be displayed in a circle graph? Discuss ideas and write down your group's best idea.

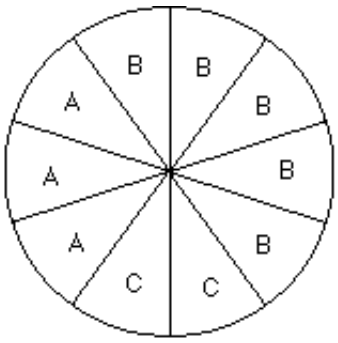
CHALLENGE POINT WORKSHEET ANSWER KEY
INTERMEDIATE LEVEL (5-8)

McINTOSH STUDENTS' FLIGHT DATA

Control Flight
Flight Results: No Ailerons



Circle Graph: No Ailerons



Section A—Green Section B—Red
Section C—Yellow Section D—Blue

1. Which section of the target did the McIntosh Team's planes hit the most? The least?
   MOST: Section B LEAST: Section D

2. What patterns do you notice in the data for their airplane?

3. Of the 10 landings, how many were in section A? In section B? In section C? In section D?

   Section A: 3 Section B: 5 Section C: 2 Section D: 0

4. Discuss how the number of landings in a section can be expressed with either a fraction or decimal. Organize the data in the displayed table.

Area	No. of Landings	Total Flights	Fraction	Decimal
Section A	3	10	3/10	.30
Section B	5	10	5/10	.50
Section C	2	10	2/10	.20
Section D	0	10	0/10	.00

5. Color the circle graph to summarize landing results for each section of the sample data.

NASA's Education Program is guided by its Strategic Plan for Education and is carried out through its nine field centers and the Jet Propulsion Laboratory.

Education programs are grouped into six general categories:

- Teacher/Faculty Preparation and Enhancement Programs
- Curriculum Support & Dissemination Programs
- Support for Systemic Change
- Student Support Programs
- Educational Technology Programs
- Mission, Research & Development, and Operations Programs

FURTHER EXPLORATION

1. Complete the Flight Direction activity contained in this packet. An airplane pattern with directions is provided.
2. Explore the following web sites for online activities and projects that connect mathematics with aeronautics:

   Off to a Flying Start (K-4)

   http://k12unix.larc.nasa.gov/flyingstart/

   PlaneMath (4-8), http://www.planemath.com/
3. Visit the NASA aeronautics centers through the Internet. Discover the range of research being done on airplanes. Begin your cross-country flight adventure at the NASA Aeronautics Headquarters home page, at http://www.hq.nasa.gov/office/aero/
4. For more information on NASA education programs and aeronautics-related materials, teachers may contact the following NASAAeronautics Educator Resource Centers:

   NASAAmes Educator Resource Center
   Mail Stop T12-A
   NASAAmes Research Center
   Moffett Field, CA 94035-1000
   (415) 604-3574
   http://ccf.arc.nasa.gov/dx/basket/trc/trchome.html/toc.html

   NASA Lewis Educator Resource Center
   Mail Stop 8-1
   NASA Lewis Research Center
   21000 Brookpark Road
   Cleveland, OH 44135-3191
   (216) 433-2017
   http://www.lerc.nasa.gov/WWW/PAO/html/educatn.htm

   Virginia Air & Space Center
   NASA Langely Educator Resource Center
   600 Settlers Landing Road
   Hampton, VA 23669-4033
   (757) 727-0900, ext. 757
   http://www.vasc.org/erc/

   NASA Dryden Educator Resource Center
   45108 North 3rd Street East
   Lancaster, California 93535
   (805) 948-7347
   http://trc.dfrc.nasa.gov/

NASA Education Link:
http://www.hq.nasa.gov/office/codef/education

NASA Langley Office of Education Web Site:
http://edu.larc.nasa.gov/

5. Leap into more aeronautic activities with NCTM and the new product, *Mission Mathematics, Linking Aerospace with the NCTM Standards. Mission Mathematics*:

   - integrates mathematics and science following the guidelines of the NCTM standards
   - motivates students to explore math and develop mathematical thinking
   - features activity books and posters for K-4, 5-8, and 9-12

Contact the NCTM, 703/620-9840, for more information, or visit their web site, at http://www.nctm.org/.

Section 4

Flight Direction Classroom Experiment Self-Contained Lesson

The following lesson plan will allow your students to duplicate the experiment that was shown during *Flight Direction*, program 1 of the Connect Series. Copies of the *Flight Direction* video can be made at the NASA Langley Educator Resource Center.

Nick Kolten, ERC Manager
Virginia Air & Space Center
NASA Langely Educator Resource Center
600 Settlers Landing Road
Hampton, VA 23669-4033
(757) 727-0900, ext. 757

INTRODUCTION

NASAengineers, scientists, and pilots constantly experiment with test designs and materials to make the best airplanes. They work to improve safety, to increase performance, and to reduce costs. Their experiments are done over long periods of time. They change their experiments by varying the conditions.

In this activity, students conduct an extended experiment in which they change and test different flight conditions. By working in pairs or small groups, they will better understand how research teams of NASA engineers and scientists must work together cooperatively to complete large projects.

The students will experiment with the position of movable ailerons on a paper airplane to discover the effect on flight. As they perform a series of test flights for each change in the ailerons, the students observe and record landing locations in a designated target area. Students display their test-flight data in circle graphs and interpret the graphs to make conjectures.

PURPOSES

- to measure and mark grids for targets
- to make and test predictions about the effects of ailerons on flight direction
- to record landing locations on a grid
- to collect, organize, display, and interpret data
- to express test-flight results as fractions and decimals
- to construct a circle graph
- to look for patterns in data to make conjectures
- to suggest future experiments to test conjectures

NCTM MATHEMATICS STANDARDS

- Statistics
- Number Sense and Numeration
- Patterns and Relationships
- Fractions and Decimals
- Measurement

NASA OBJECTIVES

- Learn about aeronautic research / activities
- Increase understanding of broad applications of aeronautics research in science / math / technology

INSTRUCTIONAL OBJECTIVES

- Conduct paper airplane experiment
- Collect, organize, display, and interpret experimental data
- Express test-fight results in visual form (e.g. graph, fractions, and decimals)
- Work cooperatively in teams to perform and present results of experiment

MATERIALS

Paper, resource pages, masking tape, and crayons

PRINT MATERIALS

- Airplane diagram
- Paper airplane pattern
- Data-Recording and Circle-Graph Sheets

MANAGEMENT TIP

This activity is intentionally planned to take several periods. Determine the number and duration of sessions and the appropriate level of instruction for your class.

GETTING STARTED

Show your class the diagram of a propeller-driven airplane on the overhead projector and discuss different parts of the airplane: propeller, engine, fuselage, cockpit, landing gear, wings with ailerons and flaps, and tail with rudder and elevators. Present the following background information.

Airplanes are equipped with special control surfaces to give the pilot a way to change the direction and altitude of flight and to slow the airplane for approach and landing. In this program the AILERON is the focus.

VOCABULARY TERM

Turns are aided by moving the AILERONS. One aileron is raised while the other is lowered. If the left aileron is down, the right one is up. If the right aileron is down, the left is up.

To have a smooth change of direction for the airplane, the rudder and the ailerons are used at the same time. The nose's movement from side to side is the yaw and the wingtip's up-and-down positions is the bank.

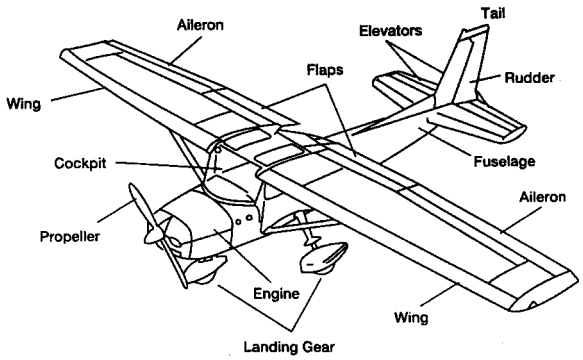
CLASS DISCUSSION

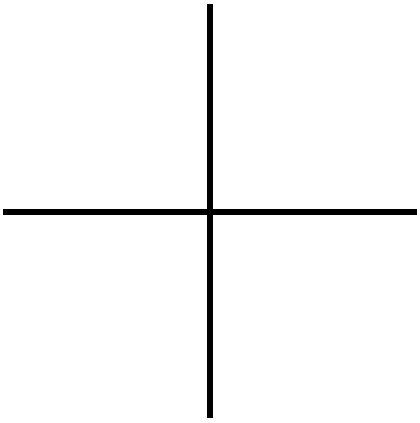
- If you were a pilot, in what different directions would you want your plane to move?
- What movable parts do you think the pilot can control from the cockpit?
- Do you think that any of the parts shown in the diagram control the direction in which a plane can travel?
- Can we do anything to a paper airplane to control its direction?

Help students mark off several target areas on the floor. The target areas should be made with two pieces of masking tape placed at right angles as shown. Each piece of tape should be at least 4 feet long. As students lay out each target area, be sure they allow enough space to stand at least 15 feet away from the target to do their test flights.

BEFORE THE ACTIVITY

Make overhead transparencies of the airplane diagram and resource pages: Simple Paper Airplane pattern, Data-Recording, and Circle-Graph sheets 1 and 2.





Target Areas

NCTM TEACHING STANDARDS

Teachers must decide the depth of content used in a discussion. To simplify the activity, use the word flaps instead of ailerons. However, if appropriate for your class, differentiate the roles of flaps and ailerons.

NCTM ASSESSMENT STANDARDS

Observe which students can use a data-collection form as directed and which students need to learn how.

DEVELOPING THE ACTIVITY

PART 1: THE CONTROL FLIGHT

Distribute the paper and ask each student to make an airplane similar to the one shown. (See Simple Paper Airplane pattern)

Demonstrate how to fly the airplane into the target by using the same controls for all 10 test flights: stand in the same location, hold the airplane in the same manner, and use the same force / thrust to throw the airplane. Instruct students how to record an X on the appropriate grid of the data-recording sheet to show the location of each landing.

Ask the students to work in teams of 2 to 4 people. First the team conducts a test flight of each partner's airplane. The team then selects the best plane. Next, one team member flies the airplane 10 times into the target spot from 15 feet away, and the other students record each landing. After all teams have completed this first series of test flights, the class is brought together to discuss their findings.

NOTE: At this point in the Flight Direction video program, there is a pause and the **Class Discussion** questions are presented as a **Challenge Point** for the students to interact.

CLASS DISCUSSION

- Which section of the target did your plane hit the most? The least?
- What patterns do you notice in the data for your airplane?
- Of your 10 landings, how many were in section A? In section B? In section C? In section D?
- How may the number of landings in a section be expressed with a fraction or decimal?
- How may this data be displayed in a circle graph? Discuss ideas and write down your groups best idea.

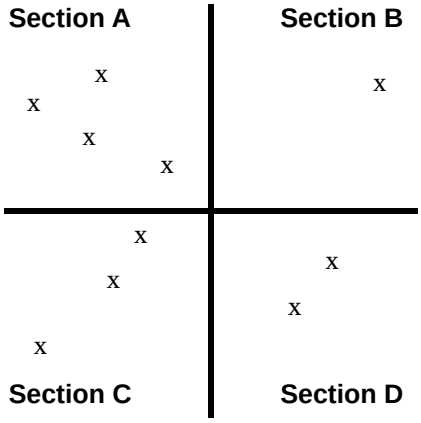
MANAGEMENT TIP

When the airplane lands outside the target, the landing should be recorded appropriately at the perimeter of that Section.

Table of Sample Data for Test Flights

Area	No. of Landings	Total Flights	Fraction	Decimal
Sec A		10		
Sec B		10		
Sec C		10		
Sec D		10		

Sample Data



NCTM ASSESSMENT STANDARDS

Talking and writing about solutions help students confirm their learning. To close Part 1, ask students to summarize the processes of expressing their data as fractions and decimals as well as displaying their data in circle graphs.

You can informally assess students' understanding of controlling variables in an experiment by asking why it is important to collect data about where their airplane lands before they change the position of the ailerons.

Next introduce or review how data can be displayed in circle graphs to show part of a whole. Demonstrate with the sample data how to color and label a circle graph for the fractions or decimals that summarize the landing results for each section of target.

Conclude Part 1 of the activity by having students write the fractions and decimals that summarize their landing results for the 10 test flights. Each team should color and label a circle graph for their data. Encourage students to share and compare their graphs.

Table of Sample Data for Test Flights

Area	No. of Landings	Total Flights	Fraction	Decimal
Sec A	4	10	4/10	0.4
Sec B	1	10	1/10	0.1
Sec C	3	10	3/10	0.3
Sec D	2	10	2/10	0.2

PART 2: FLIGHTS WITH CHANGES

Ask students to recall the names of the parts of an airplane. Show students a sample airplane in which ailerons have been cut as shown. Explain that they are going to experiment by changing the position of ailerons to see how the change affects the direction of the airplanes. Then present this task.

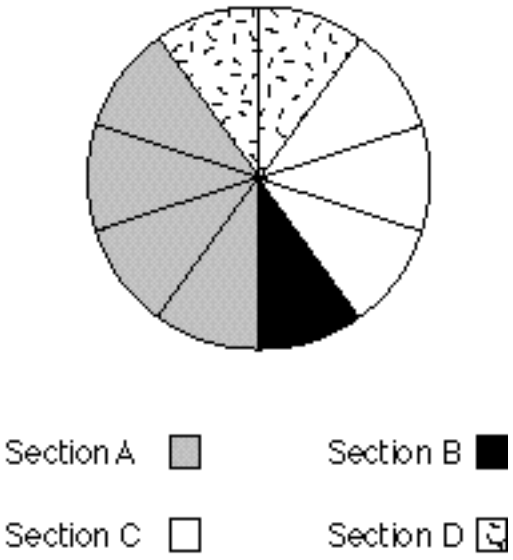
Notice where the ailerons are on the wings of this airplane. Make an aileron on each wing of your airplane by making cuts in about the same locations. On each wing, the two cuts should be about 1 inch long and should be about 1 inch apart.

CLASS DISCUSSION

- What effect do you think the ailerons will have on the landing patterns?
- Do you think that your data will show any different patterns with the ailerons in different positions? Why?
- What predictions would you like to make?

Use both data-recording and circle-graph sheets as a guide for each series of 10 test flights that teams conduct with the ailerons in different positions. Teams should follow the same procedures as in Part 1 when conducting the series of test flights for each airplane. For each different position of the ailerons, teams should display the landing results in a separate circle graph.

SAMPLE CIRCLE GRAPH



MANAGEMENT TIP

Plan different sessions for each series of test flights in part 2.

CLOSING THE ACTIVITY

When all data have been collected, help teams organize and analyze their findings. They can cut out their circle graphs, put all graphs with the same conditions together for the whole class, look for patterns, sort the graphs, and glue them onto a class chart. They can label the categories on the chart and write their findings and conclusions.

CLASS DISCUSSION

- How can we organize our graphs to compare our findings?
- What do you see in your graphs?
- Are there any similarities or differences among the graphs? Which ones? Why do you think so?
- Using your graphs, what conjectures can you make about how ailerons affected the direction of our planes? How do your conjectures match your predictions?
- What do you think happens to the air as it hits the ailerons? How do pilots use ailerons on real airplanes? Why?

FURTHER EXPLORATIONS

- Ask students what other experiments they would like to conduct to further test their conjectures about flight direction.
- Students may want to design and test different airplanes by varying the width of the wings and the size and placement of the ailerons.

RELATED ACTIVITIES IN MISSION MATHEMATICS

Different graphs are used in the other activities of the "Aeronautics" section, including line plots, stem-and-leaf plots, picture graphs, pictographs, bar graphs, and histograms.

DATA-RECORDING AND CIRCLE-GRAPH SHEET 1

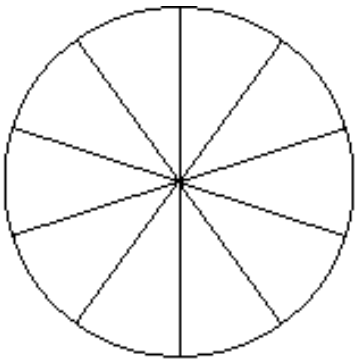
_____ Team Flight Data

Flight Results: No Ailerons

Section A | Section B

Section C | Section D

Circle Graph: No Ailerons



Section A—Green Section B—Red
Section C—Yellow Section D—Blue

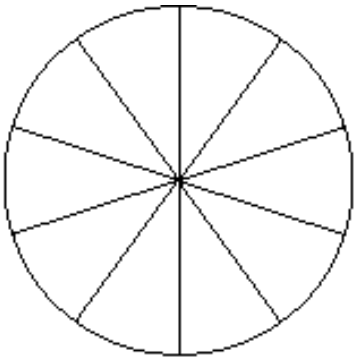
_____ Team Flight Data

Flight Results:
Left Aileron Up and Right Aileron Down

Section A | Section B

Section C | Section D

Flight Results:
Left Aileron Up and Right Aileron Down



Section A—Green Section B—Red
Section C—Yellow Section D—Blue

DATA-RECORDING AND CIRCLE-GRAPH SHEET 2

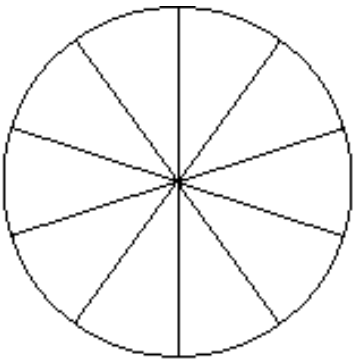
_____ Team Flight Data

Flight Results:
Right Aileron Up and Left Aileron Down

Section A | Section B

Section C | Section D

Circle Graph:
Right Aileron Up and Left Aileron Down

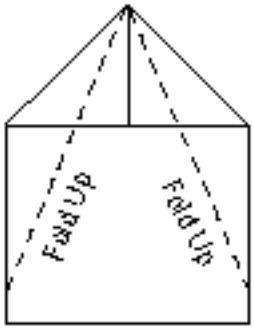


Section A—Green Section B—Red
Section C—Yellow Section D—Blue

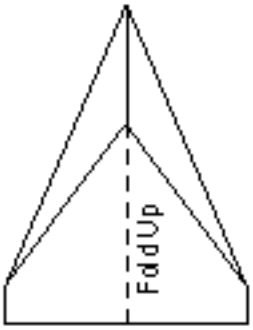
Conclusions _____

SIMPLE PAPER AIRPLANE

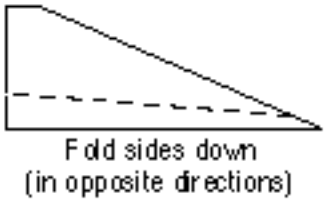
1



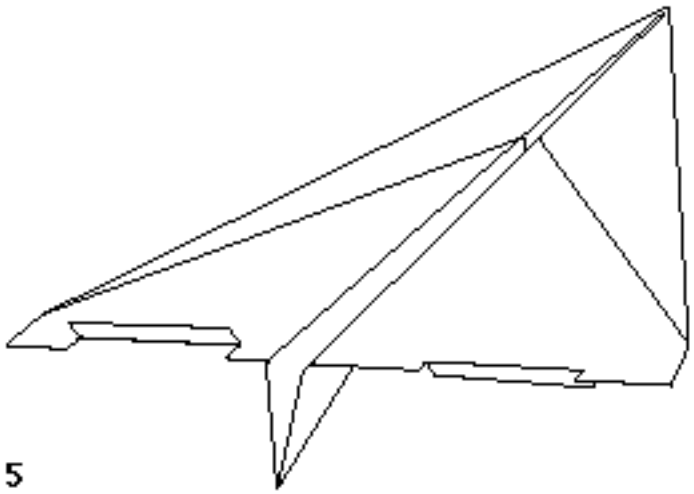
2



3



4



5

EVALUATION FORM

WHAT DID YOU THINK OF CONNECT?

Please take a few minutes to respond to the following questions.

School _____ School Division_____

Grade Level/Subject _____ No. of students participated in program _____

	Not at all		Somewhat		To a great extent
1. The program was valuable to:					
a. your students	1	2	3	4	5
b. yourself as a teacher	1	2	3	4	5
2. The written materials were valuable to:					
a. your students	1	2	3	4	5
b. yourself as a teacher	1	2	3	4	5
3. The program meet your expectations?	1	2	3	4	5
4. Did you view the program:					
a. live	Yes		No		
b. videotape	Yes		No		

What comments or suggestions do you have for the program

_____

_____

_____

_____

Thank you for your response.

Please fax evaluation form to: (757) 864-8835 or Mail to:

Attn. W.B. Williams, Jr.
NASA Langley Research Center
Office of Education
17 Langley Blvd.
Mail Stop 400 Bldg 1216
Hampton VA 23681-0001

REGISTRATION CONFIRMATION

You are registered to participate in: **Flight Direction**

The first session will be broadcast: **Thursday, October 23, 1997**
11:00 AM – 11:30 AM (5–8)
12:30 PM – 1:00 PM (K–4)

If you have a question about support materials, broadcast times, or anything else about this program, please contact CONNECT Series Hotline:

757-864-6100

You can also seek help via the Internet:

http://edu.larc.nasa.gov/connect/

or

connect@edu.larc.nasa.gov

AN INTRODUCTION TO AERONAUTICS ACTIVITY

When we watch newscasts of early attempts to fly, we get a sense of the adventure that early pioneers in flight experienced. Watching their funny-looking machines that had less successes and spectacular failures leads us to believe that manned flight was built haphazardly. Well, this belief has some truth to it, but these pioneers did engage in deliberate investigations. From these early endeavors was born the science of flight called aeronautics. Over the years, this science has grown in importance for our country. Today, aeronautics is vital to our national security and economic well-being.

The activities in this lesson can help students learn about the aeronautics activities of NASA. A good visual image that conveys NASA's commitments to aeronautics and space exploration is a Space Shuttle riding piggyback on a modified Boeing 747 airplane.

The National Aeronautics and Space Administration is known worldwide for its exploration of space. However, as the name of the agency clearly states, aeronautics has always been a major component of NASA's missions. The National Advisory Committee for Aeronautics (NACA) came before NASA. In 1958, the NACA became NASA.

NASA's aeronautical knowledge and products are used not only in experimental research aircraft but also in commercial and general-aviation aircraft. NASA continues aeronautical research in such programs as human interaction with automation and aerospace hardware; wind-tunnel research; the development of thermodynamics, materials, and advanced engines; and nondestructive evaluation and inspection methods.

The NASA aeronautics centers include the NASAAmes Research Center, NASALewis Research Center, NASA Langley Research Center, and NASA Dryden Flight Research Center. The NASA Educator Resource Centers at these locations have information on aeronautics for teachers and students. Other sources of aeronautics information are available through the NASA homepage on the Internet.